IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	: Niranjan Damera-Venkata	Art Unit	: 2625
Serial No.	: 10/698,895	Examiner	: Vo, Quang N
Filed	: Oct. 31, 2003	Confirmation No.:	2961
Title	: ERROR DIFFUSION HALFTONING WITH BANDPASS NOISE SHAPING		

Commissioner for Patents
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APPEAL BRIEF

I. Real Party in Interest

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

II. Related Appeals and Interferences

Appellant is not aware of any related appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims

Claims 1-25, which are the subject of this appeal, are pending.

Claims 1-25 stand rejected.

Appellant appeals all rejections of the pending claims 1-25.

CERTIFICATE OF TRANSMISSION

I hereby certify that this document is being transmitted to the Patent and Trademark Office via electronic filing on the date shown below.

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IV. Status of Amendments

The amendments filed April 7, 2009, have been entered and acted upon by the Examiner.

No amendments were filed after the final Office action dated July 30, 2009.

V. Summary of Claimed Subject Matter

In the following Summary, the citations in parentheses are representative of support provided in the application.

A. Independent claim 1

The aspect of the invention defined in independent claim 1 is an error diffusion halftoning method comprising operating a processor (¶ 37) to perform operations comprising the following operations. A current input is modified to produce a modified input (¶ 33; FIG. 2, elements x(m) and u(m), respectively). In this process, past quantization errors are incorporated into the current input (FIG. 2, block 218). The modified input is quantized to produce an output (¶ 32; FIG. 2, block 210). The output is processed through a data processing path having a bandpass transfer characteristic (FIG. 2, blocks 212, 214, 216), wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs (¶¶ 32-33; FIG. 2, blocks 214, 216, 218).

B. Dependent claim 3

Claim 3 depends from claim 1 and recites that the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and α is a scalar that controls pixel clustering (¶22).

C. Independent claim 7

The aspect of the invention defined in independent claim 7 is an apparatus for performing error diffusion halftoning (¶ 37; FIG. 4). The apparatus comprises a tangible memory storing instructions (¶ 37; FIG. 4), and a processor coupled to the memory, operable to execute the instructions, and based at least in part on the execution of the instructions operable to perform operations comprising the following operations (¶ 37; FIG. 4). A current input is modified to produce a modified input (¶ 33; FIG. 2, elements x(m) and u(m), respectively), wherein past quantization errors are incorporated into the current input (FIG. 2, block 218). The modified input is quantized to produce an output (¶ 32; FIG. 2, block 210). The output is processed through a processing path having a bandpass transfer characteristic (FIG. 2, blocks 212, 214, 216), wherein in the processing the processor performs operations comprising deriving an error value from the modified input and the output and diffusing the error value into future inputs (¶¶ 32-33; FIG. 2, blocks 214, 216, 218)

D. Independent claim 9

The aspect of the invention defined in independent claim 9 is an apparatus for performing error diffusion halftoning (¶ 37; FIG. 4). The apparatus comprises a processor operable to perform operations comprising the following operations. A current input is modified to produce a modified input (¶ 33; FIG. 2, elements x(m) and u(m), respectively). In this process, past quantization errors are incorporated into the current input (FIG. 2, block 218). The modified input is quantized to produce an output (¶ 32; FIG. 2, block 210). The output is processed through a data processing path having a bandpass transfer characteristic (FIG. 2, blocks 212, 214, 216), wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs (¶¶ 32-33; FIG. 2, blocks 214, 216, 218).

E. Independent claim 15

The aspect of the invention defined in independent claim 15 is a machine-readable memory storing processor-readable instructions that, when executed by a processor, causes the processor to perform error diffusion halftoning (¶ 37; FIG. 4). The error diffusion halftoning includes performing quantization, and filtering with an effective bandpass

characteristic without using an output of the quantization to directly influence an input of the quantization (¶¶ 32-33; FIG. 2).

F. Independent claim 21

The aspect of the invention defined in independent claim 21 is a printer comprising a print engine (¶¶ 37-38; FIG. 4), and a processor for performing error diffusion halftoning (¶¶ 37-38; FIG. 4). The halftoning includes performing quantization, and using an error signal filtered with an effective bandpass characteristic to influence the quantization without using a result of the quantization to directly influence an input of the quantization, an output of the quantization supplied to the print engine (¶¶ 32-33; FIG. 2).

VI. Grounds of Rejection to be Reviewed on Appeal

A. Claims 1-2, 4, 6-7, 9, 11, 13-14, 21, 23 and 25 are rejected under 35 U.S.C. § 102(b) over Kumar ("On the Phase Response of the Error Diffusion Filter for Image Half toning").

B. Claims 3, 8, 10, and 17 are rejected under 35 U.S.C. § 103(a) over Kumar ("On the Phase Response of the Error Diffusion Filter for Image Half toning").

C. Claims 5, 12, 15-16, 18-20, 22 and 24 are rejected under 35 U.S.C. § 103(a) over Kumar ("On the Phase Response of the Error Diffusion Filter for Image Half toning") in view of Shimizu (U.S. 6,999,201).

VII. Argument

A. Claim rejections under 35 U.S.C. § 102(b)

The Examiner has rejected claims 1, 2, 4, 6, 7, 9, 11, 13, 14, 21, 23, and 25 under 35 U.S.C. § 102(b) over Kumar ("On the Phase Response of the Error Diffusion Filter for Image Half toning").

1. Applicable standards for sustaining a rejection under 35 U.S.C. § 102(b)

The relevant part of 35 U.S.C. § 102(b) recites that "A person shall be entitled to an invention, unless - ... the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States." Anticipation under 35 U.S.C. § 102(b) requires that each and every element of the claimed invention be present, either expressly or inherently, in a single prior art reference. EMI Group N. Am., Inc. v. Cypress Semiconductor Corp., 268 F.3d 1342, 1350 (Fed. Cir. 2001). Anticipation must be proved by substantial evidence. In re Crish, 393 F.3d 1253, 73 USPQ2d 1364 (Fed. Cir. 2004).

2. Claims 1, 2, 4, 6 and 23

Independent claim 1 recites:

> Claim 1 (previously presented): An error diffusion halftoning method comprising operating a processor to perform operations comprising:
>
> modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;
>
> quantizing the modified input to produce an output; and
>
> processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

The rejection of independent claim 1 under 35 U.S.C. § 102(b) over Kumar should be withdrawn because Kumar does not expressly nor inherently disclose each and every element of the claim. For example, Kumar does not expressly nor inherently disclose "processing the output through a data processing path having a bandpass transfer characteristic."

In the rationale given by the Examiner in support of the rejection of claim 1, the Examiner has asserted that Kumar discloses "processing the output through a data processing path having a bandpass transfer characteristic" in the error filter h4 defined in example 2 on page 1287, in FIG. 1, and in the third paragraph on page 1285 (see page 3 of the final Office

action). Contrary to the Examiner's assertion, however, Kumar does not even hint that the error filter h(k,l) has a bandpass transfer characteristic.

Regarding the disclosure of example 2 on page 1287, the Examiner inexplicably has mischaracterized Kumar's teaching as disclosing an "error filter h4 having prominent bandpass shape at horizontal and vertical frequencies" (see page 3 of the final Office action). Contrary to the Examiner's mischaracterization, however, the disclosure of example 2 on page 1287 expressly discloses that it is the filter 1-H(w_x,w_y) that has "prominent bandpass shape at horizontal and vertical frequencies," not the filter h4 (see page 1287 of Kumar). Based on this disclosure, it is clear that the filter h4 must have highpass and lowpass shapes at horizontal and vertical frequencies in order to complement the bandpass shape of the filter 1-H(w_x,w_y). Thus, contrary to the Examiner's position, Kumar does not disclose "processing the output through a data processing path having a bandpass transfer characteristic" on page 1287; in fact, Kumar's disclosure on page 1287 contradicts the Examiner's position in this regard.

Regarding the disclosure in the third paragraph on page 1285, Kumar expressly discloses that "It is only desired that the magnitude response should be a lowpass, preferably with its pass band not less than the passband of the human visual system" (emphasis added). Thus, the cited disclosure expressly contradicts the Examiner's characterization of the disclosure as teaching "processing the output through a data processing path having a bandpass transfer characteristic."[1]

Throughout the remainder of the document, Kumar consistently discloses that the error filter h(k,l) is a low-pass filter. For example, in the first line after equation (11) on page 1284, Kumar discloses that (1-H(w_x,w_y)) is a high-pass filter, which means that H(w_x,w_y) is a low-pass filter. Kumar also discloses that "if the magnitude response of the error filter is low-pass with unity gain as zero frequency, it ensures that the low frequency spectrum of the halftone is similar to that of the input image" (page 1284, last two lines - page 1285, line 2). In addition, Kumar discloses that the three error filters defined in equations (12)-(14) are low-pass filters (see page 1285, first full ¶).

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[1] Inexplicably, the Examiner's characterization of the cited disclosure omitted the part of the cited sentence that expressly contradicts the Examiner's characterization. In particular, the Examiner omitted Kumar's express teachings that "It is only desired that the magnitude response should be a lowpass…"

Thus, the Examiner has not shown that Kumar discloses "processing the output through a data processing path having a bandpass transfer characteristic," as recited in claim 1. For at least this reason, the rejection of independent claim 1 under 35 U.S.C. § 102(b) over Kumar should be withdrawn.

Each of claims 2, 4, 6, and 23 incorporates the elements of independent claim 1 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

3. Claim 7

Independent claim 7 recites elements that essentially track the pertinent elements of independent claim 1 discussed above. In particular, claim 7 recites the "modifying", the "quantizing", and "processing" elements of independent claim 1 and, therefore, is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

4. Claims 9, 11, 13, and 14

Independent claim 9 recites elements that essentially track the pertinent elements of independent claim 1 discussed above. In particular, claim 9 recites the "modifying", the "quantizing", and "processing" elements of independent claim 1 and, therefore, is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

Each of claims 11, 13, and 14 incorporates the elements of independent claim 9 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 9 (via claim 1).

5. Claims 21 and 25

Independent claim 21 recites elements that essentially track the pertinent elements of independent claim 1 discussed above. In particular, claim 21 recites in part "a processor for performing error diffusion halftoning, the halftoning including performing quantization, and using an error signal filtered with an effective bandpass characteristic to influence the quantization without using a result of the quantization to directly influence an input of the

quantization." For the same reasons explained above in connection with independent claim 1, Kumar does not expressly nor inherently disclose "using an error signal filtered with an effective bandpass characteristic to influence the quantization without using a result of the quantization to directly influence an input of the quantization," as recited in claim 21. Therefore, independent claim 21 is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

Claim 25 incorporates the elements of independent claim 21 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 21 (via claim 1). In particular, claim 25 recites the "modifying", the "quantizing", and "processing" elements of independent claim 1 and, therefore, is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

B. Claim rejections under 35 U.S.C. § 103(a)

1. Applicable standards for sustaining a rejection under 35 U.S.C. § 103(a)

"A patent may not be obtained ... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." 35 U.S.C. §103(a).

In an appeal involving a rejection under 35 U.S.C. § 103, an examiner bears the initial burden of establishing *prima facie* obviousness. See In re Rijckaert, 9 F.3d 1531, 1532, 28 USPQ2d 1955, 1956 (Fed. Cir. 1993). To support a *prima facie* conclusion of obviousness, the prior art must disclose or suggest all the limitations of the claimed invention.[2] See In re Lowry, 32 F.3d 1579, 1582, 32 USPQ2d 1031, 1034 (Fed. Cir. 1994). If the examiner has

[2] The U.S. Patent and Trademark Office has set forth the following definition of the requirements for establishing a *prima facie* case of unpatentability (37 CFR § 1.56(b)(ii)):

> A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

established a *prima facie* case of obviousness, the burden of going forward then shifts to the applicant to overcome the *prima facie* case with argument and/or evidence. Obviousness, is then determined on the basis of the evidence as a whole and the relative persuasiveness of the arguments. This inquiry requires (a) determining the scope and contents of the prior art; (b) ascertaining the differences between the prior art and the claims in issue; (c) resolving the level of ordinary skill in the pertinent art; and (d) evaluating evidence of secondary consideration. See KSR Int'l Co. v. Teleflex Inc., No. 127 S. Ct. 1727, 1728 (2007) (citing Graham v. John Deere, 383 U.S. I, 17-18, 148 USPQ 459, 467 (1966)). If all claim limitations are found in a number of prior art references, the fact finder must determine whether there was an apparent reason to combine the known elements in the fashion claimed. See KSR, 1741. This analysis should be made explicit. KSR at 1741 (citing In re Kahn, 441 F. 3d 977, 988 (Fed. Cir. 2006): "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness").

2. Claims 3, 8, 10, and 17

Claims 3, 8, 10, and 17 are rejected under 35 U.S.C. § 103(a) over Kumar ("On the Phase Response of the Error Diffusion Filter for Image Half toning").

a. Claim 3

Claim 3 incorporates the elements of independent claim 1 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

Claim 3 also is patentable over Kumar for the following additional reasons.

Claim 3 depends from claim 1 and recites that the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and α is a scalar that controls pixel clustering.

In support of the rejection of claim 3 under 35 U.S.C. § 103(a) over Kumar, the Examiner has acknowledged that Kumar does not disclose the transfer function B(z) defined

in claim 3 (see page 7 of the final Office action). In an effort to make-up for this lack of disclosure, the Examiner has taken the position that (see page 7 of the final Office action):

> Since Kumar discloses the response of the error filter determines which part of the input image spectrum is retained by the half toning method, and which part is not (page 1284) and error filter h4 having prominent bandpass shape at horizontal and vertical frequencies, page 1287. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to have recognized Kumar disclosing wherein the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) as claimed in claim 3.

As explained above in connection with independent claim 1, however, the Examiner's assertion that the filter h4 has prominent bandpass shape at horizontal and vertical frequencies is based on an inexplicable mischaracterization of Kumar's express teachings (see page 1287). In contradiction to the Examiner's position, Kumar expressly discloses that it is the filter 1-H(w_x,w_y) that has "prominent bandpass shape at horizontal and vertical frequencies," not the filter h4 (see page 1287 of Kumar). Based on this disclosure, it is clear that the filter h4 must have highpass and lowpass shapes at horizontal and vertical frequencies in order to complement the bandpass shape of the filter 1-H(w_x,w_y). Since the rationale given by the Examiner in support of the rejection of claim 3 is not supported (and in face is contradicted) by Kumar's disclosure, there is no support whatsoever for the Examiner's conclusion that claim 3 is obvious over Kumar.

In addition, even assuming for the purpose of argument only that the Examiner's mischaracterization of Kumar's teachings was correct, the Examiner's has not even attempted to show that such an incorrect construction of Kumar's disclosure would have led one skilled in the art to process the output through a data processing path having a bandpass transfer characteristic given by the transfer function B(z) defined in claim 3. Instead, the Examiner simply asserts without any justification that the transfer function B(z) "... would have been obvious..." Such conclusory reasoning amounts to no more than a conclusory statement that cannot support a rejection under 35 U.S.C. § 103. Indeed, such conclusory reasoning only evidences the fact that the Examiner improperly has engaged in impermissible hindsight reconstruction of the claimed invention, using applicants' disclosure as a blueprint for piecing together elements from the prior art in a manner that attempts to reconstruct the invention

recited in claim 3 only with the benefit of impermissible hindsight (see KSR Int'l Co. v. Teleflex Inc., slip op. at 17: "A factfinder should be aware, of course, of the distortion caused by hindsight bias and must be cautious of arguments reliant upon ex post reasoning."). The fact is that there is no necessary correlation between the Examiner's incorrect construction of Kumar's disclosure and the transfer function B(z) defined in claim 3. Consequently, the Examiner's incorrect construction of Kumar's disclosure would not have led one skilled in the art to process the output through a data processing path having a bandpass transfer characteristic given by the transfer function B(z) defined in claim 3.

For at least these additional reasons, the rejection of claim 3 under 35 U.S.C. § 103(a) over Kumar should be withdrawn.

b. Claim 8

Claim 8 incorporates the elements of independent claim 7 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 7 (via claim 1).

Claim 8 also is patentable over Kumar for the same additional reasons explained above in connection with claim 3.

c. Claim 10

Claim 10 incorporates the elements of independent claim 9 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 9 (via claim 1).

Claim 10 also is patentable over Kumar for the same additional reasons explained above in connection with claim 3.

d. Claim 17

Claim 17 incorporates the elements of independent claim 15 and therefore is patentable over Kumar for at least the same reasons explained above in connection with independent claim 15 (via claim 1).

Claim 17 also is patentable over Kumar for the same additional reasons explained above in connection with claim 3.

3. Claims 5, 12, 15, 16, 18-20, 22, and 24

The Examiner has rejected claims 5, 12, 15, 16, 18-20, 22, and 24 under 35 U.S.C. § 102(b) over Kumar ("On the Phase Response of the Error Diffusion Filter for Image Half toning") in view of Shimizu (U.S. 6,999,201).

a. Claims 5 and 22

Each of claims 5 and 22 incorporates the elements of independent claim 1. Shimizu does not make-up for the failure of Kumar to disclose or suggest the pertinent elements of independent claim 1 discussed above. Therefore, claims 5 and 22 are patentable over Kumar in view of Shimizu for at least the same reasons explained above in connection with independent claim 1.

Claim 22 also is patentable over Kumar in view of Shimizu for the following additional reasons.

Claim 22 depends from claim 1 and recites that:

> the processing comprises
>
> > modifying the output to produce a modified output, wherein the modifying of the output comprises filtering past errors in accordance with a first low-pass filter transfer function and incorporating into the modified output the past errors filtered in accordance with the first low-pass filter transfer function, and
> >
> > subtracting the modified input from the modified output to produce a second error value
> >
> > filtering the second error value in accordance with a second low-pass filter transfer function to produce the first error value; and
>
> the modifying comprises incorporating into the current input past error values filtered in accordance with the second low-pass filter transfer function to produce the modified input.

In support of the rejection of claim 22, the Examiner has taken the position that (see page 11 of the final Office action):

> Regarding claim 22, Kumar differs from claim 22 in that he does not disclose subtracting the modified input from the modified output to produce a second error value filtering the second error value in accordance with a second low-pass filter transfer function to produce the first error value; and
>
> the modifying comprises incorporating into the current input past error values filtered in accordance with the second low-pass filter transfer function to produce the modified input.
>
> Shimizu discloses subtracting the modified input (e.g., modified input at 215, figure 2) from the modified output (e.g., g(n1, n2) or value at 245, figure 2) to produce a second error value (e.g., w(n1 ,n2), figure 2) filtering the second error value in accordance with a second low-pass filter transfer function to produce the first error value (e.g., weight coefficient lamda block 280 and associated with adaptive algorithm block 270, figure 2. Note: weight coefficient associated with adaptive algorithm to produce the quantization error e(n1, n2). Thus it is considered as second linear weighting filter) to produce the first error value (e.g., e(n1, n2) at 285, figure 2); and the modifying comprises incorporating into the current input (e.g., current input x(n1, n2), figure 2) past error values filtered (e.g., e(n1, n2) at 285, figure 2) in accordance with the second low-pass filter transfer function to produce the modified input (e.g., modified input at 215, figure 2).

The rejection of claim 22 over Kumar in view of Shimizu should be withdrawn because Kumar in view in Shimizu does not disclose or suggest all the elements of the claim.

First the Examiner's has failed to establish a *pima facie* case that Kumar in view of Shimizu discloses all the elements of claim 22. In particular, the Examiner has not shown that Kumar in view of Shimizu discloses or suggests "modifying the output to produce a modified output, wherein the modifying of the output comprises filtering past errors in accordance with a first low-pass filter transfer function and incorporating into the modified output the past errors filtered in accordance with the first low-pass filter transfer function," as recited in claim 22. Indeed, the Examiner has not even attempted to show that his proposed combination of Kumar and Shimizu discloses or suggests the "first low-pass filter transfer function" recited in claim 1. For at least this reason, the rejection of claim 22 under 35 U.S.C. § 103(a) over Kumar in view of Shimizu should be withdrawn.

Second, Kumar in view in Shimizu does not disclose or suggest filtering with first and second low-pass filter transfer functions as defined in claim 22. Instead, both Kumar and

Shimizu disclose a single lowpass filter in the feedback path (see error filter in FIG. 1 of Kumar and error diffusion filter means 230 in FIG. 2 of Shimizu). Note that the weight coefficient adjustment means 280 is not a lowpass filter; instead, it adjusts the output of the error diffusion filter means 230 (see col. 6, lines 26-38). For this additional reason, the rejection of claim 22 under 35 U.S.C. § 103(a) over Kumar in view of Shimizu should be withdrawn.

b. Claim 12

Claim 12 incorporates the elements of independent claim 9. Shimizu does not make-up for the failure of Kumar to disclose or suggest the pertinent elements of independent claim 9 discussed above (via claim 1). Therefore, claim 12 is patentable over Kumar in view of Shimizu for at least the same reasons explained above in connection with independent claim 9 (via claim 1).

c. Claims 15, 16, 18-20, and 24

Independent claim 15 recites elements that essentially track the pertinent elements of independent claim 1 discussed above. In particular, claim 15 recites in part "the error diffusion halftoning including performing quantization, and filtering with an effective bandpass characteristic without using an output of the quantization to directly influence an input of the quantization." For the same reasons explained above in connection with independent claim 1, Kumar does not expressly nor inherently disclose "filtering with an effective bandpass characteristic without using an output of the quantization to directly influence an input of the quantization," as recited in claim 15. Shimizu does not make-up for the failure of Kumar to disclose or suggest this element of independent claim 15. Therefore, independent claim 15 patentable over Kumar in view of Shimizu for at least the same reasons explained above in connection with independent claim 1.

Each of claims 16, 18-20, and 24 incorporates the elements of independent 15 and therefore is patentable over Kumar in view of Shimizu for at least the same reasons explained above in connection with independent claim 15 (via claim 1). Claim 24 recites the "modifying", the "quantizing", and "processing" elements of independent claim 1 and, therefore, is patentable over Kumar for at least the same reasons explained above in connection with independent claim 1.

VIII. Conclusion

For the reasons explained above, all of the pending claims are now in condition for allowance and should be allowed.

Charge any excess fees or apply any credits to Deposit Account No. 08-2025.

Respectfully submitted,

Date: November 11, 2009

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CLAIMS APPENDIX

The claims that are the subject of Appeal are presented below.

Claim 1 (previously presented): An error diffusion halftoning method comprising operating a processor to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

Claim 2 (previously presented): The method of claim 1, wherein the processing comprises shaping quantization noise in the output in accordance with the bandpass transfer characteristic.

Claim 3 (previously presented): The method of claim 1, wherein the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1-\alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and α is a scalar that controls pixel clustering.

Claim 4 (previously presented): The method of claim 3, wherein coefficients of the transfer functions H(z) and K(z) sum to unity at dc, and the bandpass transfer function has a mean-preserving behavior.

Claim 5 (previously presented): The method of claim 1, wherein the processing comprises low-pass filtering the output with a first linear weighting filter, generating a second error value based on the filtered output and the modified input, and low pass filtering the second error value with a second linear weighting filter to produce the first error value.

Claim 6 (previously presented): The method of claim 1, wherein the processing comprises bandpass filtering the error value into future inputs.

Claim 7 (previously presented): Apparatus for performing error diffusion halftoning, the apparatus comprising:

a tangible memory storing instructions; and

a processor coupled to the memory, operable to execute the instructions, and based at least in part on the execution of the instructions operable to perform operations comprising

modifying a current input to produce a modified input, wherein the modifier is operable to incorporate past quantization errors into the current input;

quantizing the modified input and to produce an output; and

processing the output through a processing path having a bandpass transfer characteristic, wherein in the processing the processor performs operations comprising deriving an error value from the modified input and the output and diffusing the error value into future inputs.

Claim 8 (previously presented): The apparatus of claim 7, wherein the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and α is a scalar that controls pixel clustering.

Claim 9 (previously presented): Apparatus for performing error diffusion halftoning, the apparatus comprising a processor operable to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

Claim 10 (previously presented): The apparatus of claim 9, wherein the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1-\alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and where α is a scalar that controls pixel clustering.

Claim 11 (previously presented): The apparatus of claim 10, wherein coefficients of the transfer functions H(z) and K(z) sum to unity at dc, and the bandpass transfer function has a mean-preserving behavior.

Claim 12 (previously presented): The apparatus of claim 9, wherein the processor is operable to perform operations comprising low-pass filtering the output with a first linear weighting filter, generating a second error value based on the filtered output value and the modified input, and low-pass filtering the second error value with a second linear weighting filter to produce the first error value.

Claim 13 (previously presented): The apparatus of claim 9, wherein the processor is operable to bandpass filter the error value into future inputs.

Claim 14 (previously presented): The apparatus of claim 9, wherein in the processing operation the processor is operable to shape quantization noise in the output in accordance with the bandpass transfer characteristic.

Claim 15 (previously presented): A machine-readable memory storing processor-readable instructions that, when executed by a processor, causes the processor to perform error diffusion halftoning, the error diffusion halftoning including performing quantization, and filtering with an effective bandpass characteristic without using an output of the quantization to directly influence an input of the quantization.

Claim 16 (previously presented): The machine-readable memory of claim 15, wherein the processor-readable instructions cause the processor to perform operations comprising using the filtered error signal to modify the quantization input.

Claim 17 (previously presented): The machine-readable memory of claim 15, wherein the filtering is based on the noise transfer function

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1-\alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions; and α is a scalar that controls pixel clustering.

Claim 18 (previously presented): The machine-readable memory of claim 17, wherein coefficients of the transfer functions H(z) and K(z) sum to unity at dc.

Claim 19 (previously presented): The machine-readable memory of claim 15, wherein the processor-readable instructions cause the processor to perform operations comprising: low pass filtering the quantization output with a first linear weighting filter; generating an error signal from the filtered output signal and the quantization input; and low pass filtering the error signal with a second linear weighting filter.

Claim 20 (previously presented): The machine-readable memory of claim 15, wherein the processor-readable instructions cause the processor to perform operations comprising: generating an error from the quantization input and output; and applying an infinite impulse response filter to the error signal, an output of the infinite impulse response filter used to modify the quantization input.

Claim 21 (original): A printer comprising:

a print engine; and

a processor for performing error diffusion halftoning, the halftoning including performing quantization, and using an error signal filtered with an effective bandpass characteristic to influence the quantization without using a result of the quantization to directly influence an input of the quantization, an output of the quantization supplied to the print engine.

Claim 22 (previously presented): The method of claim 1, wherein:

the processing comprises

modifying the output to produce a modified output, wherein the modifying of the output comprises filtering past errors in accordance with a first low-pass filter transfer function and incorporating into the modified output the past errors filtered in accordance with the first low-pass filter transfer function, and

subtracting the modified input from the modified output to produce a second error value

filtering the second error value in accordance with a second low-pass filter transfer function to produce the first error value; and

the modifying comprises incorporating into the current input past error values filtered in accordance with the second low-pass filter transfer function to produce the modified input.

Claim 23 (previously presented): The method of claim 1, wherein

the modifying comprises incorporating into the current input the past quantization errors filtered in accordance with a bandpass filter transfer function to produce the modified input, and subtracting the modified input from the output to produce the error value.

Claim 24 (previously presented): The machine-readable medium of claim 15, wherein the machine-readable medium stores processor-readable instructions causing the processor to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

Claim 25 (previously presented): The printer of claim 21, wherein the processor is operable to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

EVIDENCE APPENDIX

There is no evidence submitted pursuant to 37 CFR §§ 1.130, 1.131, or 1.132 or any other evidence entered by the Examiner and relied upon by Appellant in the pending appeal. Therefore, no copies are required under 37 CFR § 41.37(c)(1)(ix) in the pending appeal.

RELATED PROCEEDINGS APPENDIX

Appellant is not aware of any decisions rendered by a court or the Board that will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal. Therefore, no copies are required under 37 CFR § 41.37(c)(1)(x) in the pending appeal.